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METODIKA PROGNOZIROVANIYA CHISLENNOSTI KETY ONCORHYNCHUS KETA
/WALBAUM/ I EE OPRAVDYVAEMOST'

THE METHODOLOGY OF FORECASTING THE NUMBERS OF CHUM SALMON
ONCORHYNCHUS KETA /WALBAUM/ AND ITS JUSTIFICATION

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The data on the reproduction indexes of chum salmon in the Tym' River basin, northeastern coast of Sakhalin, collected over the past 25 years have permitted us to calculate the size of generations, the rate of maturation and the coefficient of return (K_r) of the generations as a whole, as well as of individual age groups with regard to the number of juvenile downstream-migrants. The forecasting includes the total number of downstream-migrants from the natural spawning grounds and the Ado-Tymovskii fish-rearing station. An analysis of these data carried out in 1985 made it possible to develop a methodology of forecasting the size of a population one or two years in advance.

We had at our disposal also the information on temperature of the surface layer of water in May-July, 1964, at the northeastern coast of Sakhalin, the foraging area of juvenile chum. This has permitted us to understand the effect of thermal conditions at the outset of marine foraging on the K_r of different generations. As a result, we obtained a positive linear relation between the total degree-days in June-July and the K_r (Fig. 1) described by the equation:

$$y = -0.358 + 0.00238 \cdot x$$

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The relation of the coefficients of return of the Tym' River chum and the number of degree-days in the coastal area of northeastern Sakhalin in June-July.

Зависимость коэффициентов возврата лосося реки Тимь
от количества градусо-дней в прибрежье северо-
-восточного Сахалина в июне-июле

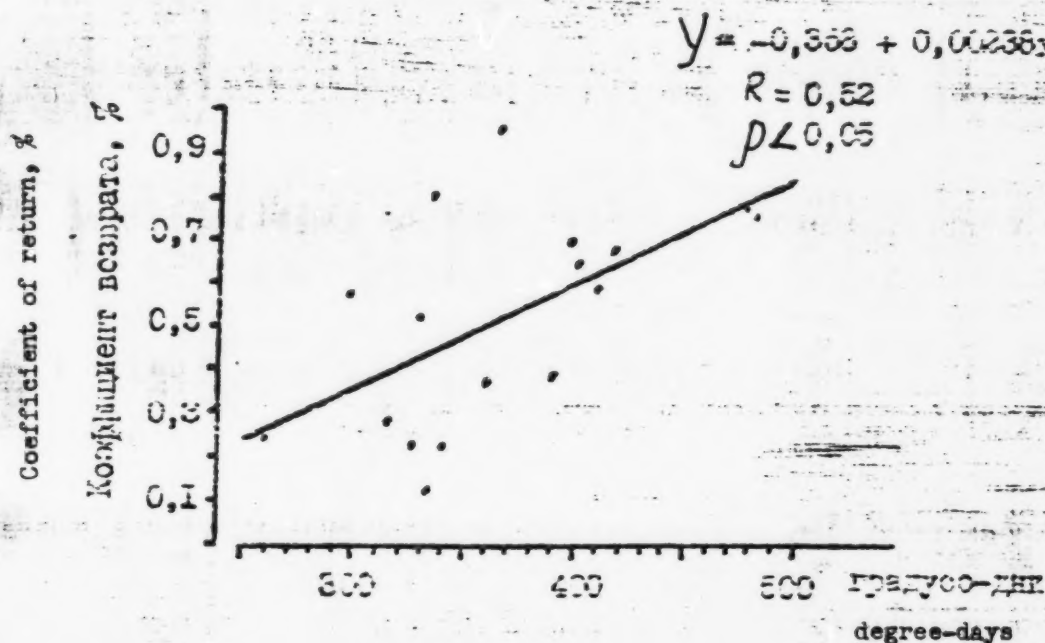


Рис. 1

Fig. 1

$R = 0.52$; $P < 0.05$, where

x - number of degree-days in June-July.

The existence of this relation makes it possible in principle to forecast the size of a population two years in advance.

The more exact forecasting of the size of a chum population is arrived at on the basis of the age of previous year's population. The forecast uses the approach of F. Bird (1982) to forecasting the numbers of chum in the Kotsebu Gulf one year in advance. According to this method essentially the abundance of a chum generation is manifest in all its age groups from the youngest to the oldest. It follows therefrom that, considering a period of several years, there should be a positive relation between two contiguous age groups.

The size of the younger age group ($2+$) is determined from the average K_r value for three-year olds over a period of several years. The relation between K_{r3+} and K_{r2+} is described by the equation:

1. $y = 0.24 + 6.41 \cdot x$; $R = 0.60$; $P < 0.01$ (Fig. 2),

the relation between K_{r4+} and K_{r3+} by the equation

2. $y = 0.018 + 0.359 \cdot x$; $R = 0.82$; $P < 0.01$.

The forecasted coefficient of return for four-year olds calculated according to the first formula has a low value ($R = 0.60$) and the share of fishes of this age group in the migration usually amounts to 50-70%. To achieve a higher degree of reliability in forecasting with reference to the four-year olds, we have corrected this relation in accordance with the generations of pink salmon. Taking into account the fact that the dates of downstream migration of juvenile pink salmon and chum are close to each other, one may assume that the conditions of the growing period in the sea during the first weeks following the migration have about the same effect on the survival of generations of both species and their numbers should be in the same range. It has been noticed that in the years of high numbers of this short-cycle species, heavy runs of the corresponding generation of chum are observed. Thus, the large runs of pink salmon in all the regions of reproduction in Sakhalin, including the northeastern coast in 1985, were interpreted by us as an indication of high numbers of four-year old chum (the dominant age group) in the return of 1987. Indeed,

a higher return of four-year olds fully confirmed our assumption. The overall error in the calculated value of the population size (including the three-year and five-year olds) as compared with the actual one amounted in 1987 to 24.4%. The year of 1986 was marked by extremely low numbers of chum, a fact noted in both the preliminary and the corrected forecast, the error in the justification amounting to 14.14%. In the course of two years (1986-1987), the methodology was tested successfully and introduced into production, helping the fishing industry adjust to the lowest and highest numbers of chum population.

The error in retrospective forecasting two years in advance for 1983-1985 fluctuated from -13.4 to +13.7%. The error in the forecasts one year in advance for the same years fluctuated from -31.0 to +1.8%.

The system of quotas introduced in chum fishery on the Tym' River has been justified by the stability of the industry over a period of several years. According to the new methodology of forecasting the size of the population, the commercial catch of chum is calculated from the regression equation:

$y = 21.15 + 0.01925 \cdot x$, where x is the forecasted abundance of chum in thousands of specimens.

This equation was obtained as a result of the assumption that in years of low numbers (200000 specimens) the commercial catch should not exceed 25% and in years of high numbers (1500000 specimens) 50%. The equation was obtained for the regression line traced through two points having the coordinates (200; 25) and (1500; 50).

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The commercial catch of chum changes every year depending on the forecast of the population size. In the future this methodology can be perfected by more frequent taking of samples (every five days) to determine the age of chum. This will increase the precision of determining the number of fishes in the 2+ age group, the reliability of forecasting for the 3+ group and of the forecast as a whole.

Return of four-year olds, %

Возврат четырехлеток, %

0 0,2 0,4 0,6 0,8 1,0 1,2 1,4

a

$$y = 0,24 + 6,41x$$

$$R = 0,60; p < 0,01$$

The relation between the coefficients of return of four-year old Typh' River chum and the coefficients of return of the three-year olds (a); the same for the four and five-year olds (b).
Зависимость коэффициентов возврата четырехлеток от коэффициентов возврата трехлеток (a); то же для пятилеток и четырехлеток (b).

0 0,02 0,04 0,06 0,08 0,10

Возврат трехлеток, %

Return of five-year olds, %

Возврат пятилеток, %

0 0,1 0,2 0,3 0,4 0,5

b

$$y = 0,018 + 0,359x$$

$$R = 0,82; p < 0,01$$

Рис. 2

Возврат пятилеток, %

0 0,2 0,4 0,6 0,8 1,0 1,2 1,4

Return of three-year olds, %

Return of four-year olds, %